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THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE
SECTION B—PHYSICS. I.

THE annual meeting of the American Association for the Advancement of Science, Section B, was held in the Ryerson Laboratory of the University of Chicago, December 30 and 31, 1907, January 1 and 2, 1908. This was a joint meeting with the American Physical Society. Each society held a short session for the transaction of routine business, but all of the meetings for the reading of papers were joint sessions of the two organizations.

The presiding officers were Professor Dayton C. Miller, of the Case School of Applied Science, vice-president and chairman of Section B, and Professor Edward L. Nichols, president of the American Physical Society. Other officers of Section B present at the meeting were the retiring vice-president, Wallace C. Sabine; the secretary, Alfred D. Cole; member of the council, Henry Crew; member of the general committee, H. S. Carhart; members of the sectional committee, W. C. Sabine, D. C. Miller, A. D. Cole, F. E. Nipher, E. L. Nichols and A. P. Carman (elected at this meeting to serve for five years).

For the next annual meeting, to be held at Baltimore in the convocation week of 1908–9, and for the summer meeting to be held at Hanover, N. H., during the week beginning June 29, 1907, the officers elected are:

Vice-president and Chairman of Section B—Karl E. Guthe.

Retiring Vice-president—Dayton C. Miller.

Members of the Sectional Committee—D. C. Miller, K. E. Guthe, A. D. Cole, F. E. Nipher, E. L. Nichols, A. Trowbridge, E. B. Rosa, A. P. Carman.

In the afternoon of December 31, the retiring vice-president, Professor Wallace C. Sabine, delivered a very interesting address on "The Origin of the Musical Scale." This was followed by an instructive and entertaining account of "Physical Research at a Mountain Observatory," by Professor Geo. E. Hale, of Mt. Wilson, California. Joint meetings of the two societies were held on Monday, Tuesday, Wednesday and Thursday. The attendance was uniformly large and fully one hundred and fifty were present to hear the vice-presidential address. Fifty-two papers were presented covering a wide variety of topics, and many of them of very great interest. There was a hotel headquarters for physicists, a feature which added much to the pleasure and profit of the meeting.

The abstracts and titles of the papers presented at the joint-sessions of the two societies are given below.

The Discharge of Electricity from Pointed Conductors: John Zeleny, University of Minnesota.

The way in which the discharge of electricity from steel sewing needles and from 12° cones, depends upon the sharpness or diameter of the points, has been studied. The potential required to start the positive discharge from these points can in each case be represented by a formula involving the diameter of the point. The relation between the potential of a point and the current flowing from it can be represented in each case by a formula involving the diameter of the point and the potential required to start a current. During the positive discharge from steel points masses of iron oxide form on the tips of the points. This also occurs to a much smaller extent during the negative discharge. The current, flowing to a spherical surface from a point placed at its center of curvature, distributes itself quite uniformly over the whole surface of the hemisphere opposite. With diminution of pressure the discharge between a point and a plane takes place at gradually lower and lower potentials, and the current increases more and more rapidly with change of voltage. Below a pressure of one centimeter the potential required for the discharge drops rapidly to about 400 volts as the pressure is reduced to a few hundredths of a centimeter, and then at about a hundredth of a centimeter it begins to increase again rapidly.

Notes on Spark Potentials: R. F. Earhart, Ohio State University.

Point and Plane.—Measurements were made on the P.D. required to cause a discharge between a needle point and a plane surface, for very small distances.

Potentials were secured from a bank of storage cells. Distances were measured by means of an interferometer.

Curves are shown representing the relation between distance and potential. One family of curves represents discharge from a positive point for pressures of 75 cm., 37 cm. and 25 cm. In a similar manner results obtained for point negative are shown.

The least potential required for ionization of air under these conditions is 338 volts, a value somewhat less than has been previously determined for plane electrodes.

Potentials less than 338 volts can produce a discharge, but of a different character. Such discharge is probably produced by the projection of corpuscles or metal atoms. The polarity of the point does not influence the discharge for the abnormally small distances. For greater distances discharge occurs more readily from a negative than for a positive point.

Discharge between Metal Electrodes for Potentials Less than Ionizing Potentials.—Hobbs has shown that discharge produced by potentials less than an ionizing potential depends on the character of the metal electrode. Such discharge can be secured through greater distances if Al electrodes are used than if Pt were employed.

Using electrodes of Pt, Al and Ag, in the various permutations and plotting P.D. and distance, I have found that discharge is not determined by the character of the negative electrode, but rather by the electrode having the lower potential gradient, irrespective of its polarity.

This indicates that the discharge under these conditions is not carried entirely by negative corpuscles.

The Influence of Humidity upon the Electrical Discharge from Points in Air: JOHN ZELENY, University of Minnesota.

A study has been made of the discharge from a point in air of various degrees of humidity. A complete potential-current curve was attained for each case, and from the results curves were drawn showing how the potential required to produce a given current varies with the humidity of the air. The potential required to start the positive discharge was found to diminish slightly (about 3 per cent.) as the humidity increased from 0 to 100 per cent. The potential required to produce a positive current (25×10^{-7} amp. to 100×10^{-7}) increased about 6 per cent. for the same change in humidity. The potential required to produce a negative current also increased with the humidity of the air, the total increase being about 16 per cent. for the whole range.

Radioactivity of a Smoke-laden Atmosphere: S. J. ALLEN, University of Cincinnati.

This paper gives an account of a series of observations on the rate of decay of the radioactivity of the air at Cincinnati, during the last eight months. The atmosphere at Cincinnati is very smoky and it was therefore thought interesting to observe what effect the smoke particles might have on the rate of decay.

An endless copper wire running over two insulated wooden pulleys was suspended about 20 feet from the ground, and could be charged to a high potential by means of a large static machine. The length between the pulleys was about 180 feet, thus giving 360 feet of wire for the activity to be deposited on.

The active substance deposited on this wire was removed and tested for its activity in the usual manner. In some of the observations the rate of leak method was used and in others the activity was measured by means of the new null reading instrument devised by the author and described in an accompanying paper.

The active substance was collected on the wire under three different conditions: (1) The wire was charged negative, (2) the wire was charged positive, (3) the wire was uncharged.

About fifty decay curves in all were obtained.

The main facts brought out in this investigation may be summarized as follows:

1. When the wire was charged negatively a very large amount of activity could be obtained. When charged positively only a small amount. When uncharged the amount obtained was quite considerable.

2. The decay curves obtained differed widely, the period of decay (time taken to fall to half value) varying from 30 to 80 minutes.

3. Only two simple exponential curves could be obtained which extended over any appreciable length of time. One gave a period of about 38 minutes and the other a period of 30 minutes. About one third

of the curves were approximately exponential and had a period from 36 to 40 minutes. There thus seems to be a period of decay of about 38 minutes.

4. At least eight or ten of the curves showed a slow rate of leak remaining for many hours. In two or three cases this rate of decay was identified with that of thorium excited, having a period of decay of about 11 hours.

One may, I think, conclude from these results that there is a simple exponential decay with a period of 28 minutes, another one of 38 minutes, and some evidence of a much slower rate of decay with a period of over 50 minutes. If the period is over 60 minutes one can be certain that thorium excited is present. The period of 28 minutes agrees with that of radium. The results of this paper then show that in general the decay curves of the radioactivity of the atmosphere will be irregular and made up of several rates of leak due to radium-excited activity and in many cases also to thorium excited. The effect of smoke particles is undoubtedly the same as that of snow and rain, as observed by other experiments, though the rate of decay is in general different.

On the Charge carried by the Negative Ion of an Ionized Gas: R. A. Millikan and L. Begeman, University of Chicago.

The paper is a discussion of the sources of error in preceding determinations of e, and a description of attempts to eliminate some of these sources of error. In its essentials the method employed was that used by H. A. Wilson. The source of ionization was radium. The potential difference established between plates 5 mm. apart in the cloud chamber ranged from 1,600 to 3,000 volts. The expansion was of such value as to cause the fall in pressure to be between 22 and 24 cm. of mercury, its initial value being about 75 cm. The cloud was timed as it fell between the cross hairs of a short focus micrometer telescope, so set that the distance between these cross hairs corresponded to an actual fall of 2 mm. The degree of accuracy with which results could be duplicated was shown from a typical set of observations.

The results of ten different sets of observations made with fields of the indicated strengths were as follows:

Field Strength				
1,600 volts	10.67	E.S.	3.81×10^{-10}	
2,100 "	14.00	"	3.89	"
2,400 "	16.00	"	4.10	"
2,950 "	19.67	"	4.25	"
1,600 "	10.67	"	4.34	"
1,600 "	10.67	"	3.66	"
2,100 "	14.00	"	4.10	"
2,250 "	15.00	"	3.94	"
2,350 "	15.67	"	4.37	"
2,750 "	18.30	"	3.84	"
Mean			4.03×10^{-10}	

Distribution of Ionizing Energy about X-Ray Tubes: Wm. R. Ham, University of Chicago.

The distribution of ionizing energy about X-ray tubes was examined by an electroscope method in order to determine whether the uniformity in distribution obtained by previous observers by photographic and fluoroscopic methods would be found to hold.

Working at one and one half meters distance from the center of the tube there was found to be a wide variation in ionizing energy in certain planes. Thus:

1. In the plane determined by the axis of the cathode and the normal to the target there are large variations, the energy along the normal being about one half as great at a point 60° from the normal, where it is a maximum.

2. In the plane at right angles to the preceding plane and containing the normal to the target there are also variations as shown by a large number of curves.

Velocity of the Negative Ions produced by the Ultra-violet Rays. ALOIS F. KOVÁŘÍK, University of Minnesota.

Rutherford, adopting the alternation of the field method, found the velocity of the negative ion produced in air at atmospheric pressure by the ultra-violet rays to be 1.41 cm. per sec. for a potential gradient of 1 volt per cm. Lenard, adopting Zeleny's method of driving a current of air against the motion of the ions found the velocity to be 3.13 cm. per sec. In the present experiments the former method was used, making the alternations of the potential of the field by means of a sechommeter. With rates of alternations differing by more than 100 per cent. the values of the velocity of the negative ion in air at atmospheric pressure were found concordant within limits of experimental error and the average of the values obtained is 2.05 cm. per sec. for a potential gradient of 1 volt per cm. Reducing the pressure from 76 cm. to less than 2 mm., the velocities were measured. The products of the velocities by the ratio of their corresponding pressures to 76 gives uniform values whose average is 2.09 cm. per second. The velocity in moist air at atmospheric pressure is found 10 to 15 per cent. less than in dry air. Experiments will be carried on with different gases, pressures, and also temperatures.

Absorption Spectra of Röntgen Rays, measured by a Radiomicrometer: J. M. ADAMS, Harvard University.

It has previously been shown photographically that the Röntgen rays from an ordinary focus tube are heterogeneous, that metals show selective absorption toward the different kinds of rays, and that this selective absorption follows different laws with the various metals. The spectrum used in the present paper was obtained by the same method that was used in making the photographs above mentioned, and narrow slits taken from different parts of the spectrum were examined by the radiomicrometer. It was usually found that the beam proceeding from any one of these slits consisted chiefly of rays of one kind, upon which was superposed a small quantity of rays of other kinds. The latter rays were easily removed from the beam by transmission through a metallic sheet of proper thickness, and the beam thus purified satisfied a test for homogeneity, in that its quality, judged by its penetrating power for various substances, was not changed by further transmission through metallic sheets. A beam of rays direct from an ordinary focus tube, on the contrary, shows a decided change of quality after each transmission.

Absorption spectra for metallic sheets of different materials and thicknesses were obtained by placing the radiomicrometer in various regions of the spectrum, and plotting its deflections, reduced by the interposition of the metallic sheet, as ordinates against the distance from one end of the spectrum as abscissæ. The resulting curves in some cases were practically straight lines, indicating by their slope that the rays produced by the swiftest cathode particles had the greatest penetrating power; while in other cases there were well-marked maxima and minima of absorption in going along the spectrum.

A Mechanical Effect accompanying Magnetization: O. W. RICHARDSON, Princeton University.

On the view that the magnetic properties of bodies are due to the motion of electrons in closed orbits, magnetization is accompanied by the acquirement by the revolving electrons of a resultant moment of momentum about the direction of magnetization. The magnitude of this moment of momentum is calculated, and it is shown

that in the general case the moment of momentum per unit volume is proportional to the intensity of magnetization. In the case where all the revolving electrons are of the same sign, the coefficient of proportionality reduces to $2m/e$ where m is the mass and e the charge of an electron. If, as is generally assumed, the revolving electrons in all real bodies are alike as to mass and charge, this coefficient should be the same for all substances. Experiments are being made at Princeton University to detect the existence of this moment of momentum, which should give rise to effects within the reach of experimental measurement.

Ionization of Gases at High Pressures: Henry A. Erikson, University of Minnesota.

This paper gives the results of an experimental investigation of the ionization produced in gases at high pressures by the γ rays of radium.

The results show that the current obtained with a constant difference of potential between the electrodes becomes a maximum at a certain pressure and that a further increase in the pressure causes a decrease in the current.

The position of the maximum point depends upon the difference of potential. When the potential difference is 18 volts between concentric cylindrical electrodes separated by about 6 mm., the maximum is at a pressure of 70 atmospheres, and the current at 400 atmospheres is 60 per cent. of the maximum. With a difference of potential of 1,000 volts the maximum is at 150 atmospheres, the current at 400 atmospheres being about 78 per cent. of the maximum.

The results also show that some of the ions remain uncombined for some time after the rays have been discontinued. At the end of an interval of 20 seconds the number of ions obtained from air at 200 atmospheres, with a difference of potential of 1,000 volts, is about 8 per cent. of the number obtained at the end of an interval of 0.1 second, and at 400 atmospheres the number is about 13 per cent. for the same intervals.

The current-pressure curves for carbon dioxide are similar to those for air, up to the pressure at which the gas liquefies.

The Variation of Apparent Capacity of a Condenser with the Time of Discharge and the Variation of Capacity with Frequency in Alternating Current Measurements: Bruce V. Hill, Chicago.

It has been shown that the capacity of a condenser, as measured by the ballistic method, varies greatly with the time during which the condenser is connected with the galvanometer. The present study was designed to investigate this further and also to learn the behavior of capacities used in ordinary telephone circuits.

For measuring short time intervals a falling weight, operating make-and-break keys was used. Intervals as short as 1/6,000 of a second could thus be read. Discharge times varied from .0001 second to 11 seconds. A D'Arsonval ballistic galvanometer was used. With a mica condenser the apparent capacity was found independent of the time of discharge, but in four paper condensers the absorption was considerable.

A small inductor generator was used in testing the dependence of capacity upon frequency. The mica condenser fell 1 per cent. in capacity as the frequency varied from 60 cycles to 3,000. A paper condenser fell 2.5 per cent., which is too small to be taken account of in practical telephone work.

An Examination of Certain Alternating Current Circuits including those Con-

taining Distributed Capacity: CARL KINSLEY, University of Chicago.

In alternating current circuits, particularly those approaching the condition of resonance, the self-induction, capacity and resistance as used are frequently far from correct.

(1) The *self-induction* must include that of the source. If a small transformer is used its self-induction may be a considerable part of that of the circuit. (2) The *capacity* must be measured with the same conditions under which it is employed in the circuit. (3) The resistance of the circuit is both the ohmic resistance and the apparent resistance introduced by hysteresis. The importance of each correction was discussed and illustrated.

The use of periodic and aperiodic current variations over artificial lines was studied by means of the Braun tube. The conditions which must be satisfied in working over long lines were discussed. The paper was illustrated with diagrams and lantern slides.

The Capacity of Paper Condensers and Telephone Cables: ANTHONY ZELENY and A. P. ANDREWS, University of Minnesota.

The free-charge capacities of various paper condensers and a telephone cable were compared with their capacities as obtained by the ordinary method where the galvanometer remains connected during the whole period of its throw (A. Zeleny, *Physical Review,* 1906, Vol. 22, p. 65).

The accuracy with which the free charge can be determined is shown by discharge curves which give the relation between the quantity and the time of discharge. In most cases, the free charge determinations can be made to within one tenth of one per cent., and the capacities as obtained by the ordinary method are shown to be from 2 to 300 per cent. greater than the free charge capacities, the amount of difference depending on the condenser.

Errors are shown to exist in the present methods of determining the specific capacities of dielectrics and in the resistance of dielectrics as obtained by the loss-of-charge method.

A Hydrogen Peroxide Cell: H. T. BARNES and G. W. SHEARER, McGill University. (Read by title.)

Two papers have been presented before the American Electrochemical Society by one of the authors in conjunction with H. M. Tory and G. H. Cole, where the results of experiments on the effect of dissolved gases in water on metal surfaces have been given. In the second paper a cell was described which consisted of electrodes of aluminum and magnesium in a solution of aluminum sulphate, to which some hydrogen peroxide was added. Aluminum metal behaves in a peculiar manner in contact with dissolved air, or oxygen, and becomes electronegative to a similar aluminum electrode in water free from dissolved air. Magnesium does not show this effect: hence a cell with the two metals for electrodes has a comparatively large E.M.F. developed between them when dissolved air or oxygen is introduced. The effect is considerably increased by adding hydrogen peroxide. Acting on the suggestion of Professor Bancroft, tests were applied to the water in which clean aluminum had stood for a few hours, and a measurable quantity of hydrogen peroxide was detected. This was developed from the action of the dissolved oxygen on the aluminum, probably according to the following reaction, also suggested by Bancroft:

$$2Al + 6H_2O + 6O = Al_2(OH)_6 + 3H_2O_2.$$

The amount of yield of the peroxide was considerably increased in several ways. Without dissolved air no trace of peroxide

was observed. The generation of the hydrogen peroxide completely explains the abnormally high E.M.F. developed between two metals so close together in the electrochemical series.

The Heat of Dilution of Aqueous Salt Solutions: F. L. Bishop.

At the meeting of the American Physical Society held in Chicago in 1906 the author read a paper describing a new form of calorimeter for certain thermochemical measurements and gave some preliminary results on the heat of dilution. The apparatus has since been perfected, tested and determinations made of the heat of dilution of sodium, barium, and potassium nitrates and potassium chloride when dissolved in water.

These results show that the heat of dilution is a linear function of the concentration when the concentration is expressed in weight normal solutions. If we represent by U the heat in calories per gram-molecular weight of the substance and by C the concentration, then dU/dC is a constant within the limits of concentration used. Now since $C = I/v$ where v represents the volume of water in which one mol of the substance is contained, we have that $dU/dv = a/v^2$ where a is some constant. This shows that as the concentration approaches zero the heat effect caused by the addition of a definite amount of solvent dv to the solution approaches zero. These results would seem to show that there is a similarity between the heat of dilution of a solution and the Joule-Thomson effect in gases for which, as is well known, the same expression holds true. They also indicate that the osmotic pressure P, like the gas pressure in van der Waals's equation, must be corrected by a term a/v^2 representing the attraction of the molecules.

Determination of the Fusion Points of Sodium Nitrate and Potassium Nitrate: Floyd R. Watson, University of Illinois.

The object of the investigation is to determine a series of definite melting points of salts from 300° to 1,400° centigrade that will be helpful in the calibration of thermo-elements and resistance thermometers.

The determination of the fusion points of the nitrates of sodium and potassium has developed a method that is sensitive, and has opened the way for the more difficult problem of determining fusion points of salts that melt at higher temperatures.

The salts were melted in a hard glass tube which was surrounded first by a small air space, then by a hot bath of mixed salts. The heating was effected by gas flame and electric current. Temperatures were found by means of a copper constantan thermo-element; the E.M.F. of the latter being determined by a potentiometer. Readings of E.M.F. were taken to microvolts by having the bridge wire of the potentiometer ten meters long, and by arranging the bridge resistance to be only a small part of that of the potentiometer circuit. A certificated cadmium cell was used as a standard E.M.F. The thermo-element was calibrated for ice, steam and boiling sulphur points.

Results of a number of preliminary observations give the temperature of fusion of sodium nitrate as 302° centigrade, and of potassium nitrate as 331°. Apparatus is now being constructed that will allow these results to be verified with a platinum platinum-rhodium thermo-element, and which will also furnish a means of determining fusion points of salts that melt at higher temperatures.

A New Apparatus for Measuring Electrolytic Resistance: Arthur Whitmore Smith, University of Michigan.

The principal object in the design of this cell is to present the concept of "molecular conductivity" of an electrolyte in such a clear and concise form that no one who is capable of making electrical measurements can misunderstand it. The apparatus consists of a strong glass tube provided with a small side tube for filling. Both ends are ground plane and closed by platinum-faced electrodes, the whole being firmly clamped together in a suitable framework. Good insulation between the electrodes is provided by making a portion of this frame of ebonite. Crushing strains due to the unequal contraction of glass and metal are avoided by the use of heavy rubber washers, one on each side, which take up the extra length without much increase in pressure. It has been found that a moderate pressure is sufficient to prevent leakage between the ends of the glass tube and the metal electrodes. The apparatus is supported by four short legs, one at each corner.

The resistance of the column of liquid contained in this tube is measured by the method of Wheatstone's bridge, using a telephone and alternating current, and the specific conductivity, c, or the conductivity of a centimeter cube of the solution from one face to the opposite one, is computed in the usual way.

The molecular conductivity, μ, of the electrolyte is then defined as the conductivity of a centimeter cube of the solution per gram molecule of salt within this cube. In symbols,

$$\mu = c/m,$$

where m denotes the concentration of the electrolyte expressed in gram molecules per c.c. of the solution.

Heat of Evaporation of Water: A. W. SMITH, University of Michigan.

The heat of evaporation of water is one of the important constants of nature. It has far-reaching practical applications, especially at high temperatures, while at low temperatures it enters into many problems of the physicist, the chemist and the meteorologist. Unfortunately, few determinations have been made at ordinary temperatures, and to fill this want my recent work was undertaken. The method employed was to draw a stream of dry air through the water and determine the amount of water evaporated by again drying the air and weighing the water thus collected. Heat to maintain a constant temperature was supplied by an electric current and the results are expressed in terms of international joules per gram of water evaporated.

The present paper gives the final corrected results expressed in terms of "mean calories" as well as in joules. The true value of the E.M.F. of a Clark cell at 15° C. is probably much nearer 1.433 volts than the legally accepted value, 1.434 volts. It is further shown that for this purpose at least, the most probable value of J is 4.1836 joules per mean calorie. Using these factors brings my results and those of other investigators at both higher and lower temperatures into perfect agreement. It is, therefore, possible to give the values of the heat of evaporation of water for the entire range of temperature from 0° C. to 100° C. with a very high degree of certainty at the lower temperatures and probably not over 0.2 per cent. error at 100° C.

The values of the heat of evaporation determined by the various investigators are plotted on a sheet of accurately engraved cross-section paper, and the nearest smooth curve is drawn through the points thus located. From this curve are then obtained values corresponding to temperature intervals of 5° C. These values decrease from 596.3 calories at 0° to 538.0 at 100°.

A Galvanometer Scale for the Direct Reading of Temperatures with Thermo-electric Couples: Anthony Zeleny, University of Minnesota.

An accurate scale for use with thermo-electric couples for the direct reading of temperatures is obtained by making the magnitude of the individual scale divisions proportional to the first differential coefficient, de/dt, of the equation for the particular couple employed.

With the proper resistance in the circuit, and with a galvanometer in which the deflections are proportional to the current, any number of such consecutive divisions represents the deflection produced when the temperatures of the junctions are those indicated by the lines at the extreme ends of those divisions.

The movable scale is set, when the circuit is open, to indicate the temperature of the known temperature junction, and then when the circuit is closed, the reading obtained indicates the temperature of the other junction.

The Use of the Bunsen Ice Calorimeter for Accurate Heat Measurements: H. T. Barnes and Franklin H. Day, McGill University. (Read by title.)

In applying the Bunsen ice calorimeter for some measurements of the heating effects of some of the radioactive changes an effort was made to eliminate the uncertainty which always appears in the want of steadiness of the reading. It is a well-known fault with this type of instrument, that the readings are never steady, but have always to be corrected for a slow freezing or melting going on inside the instrument. The creep or "gang" may be reduced in several ways: Bunsen, 1871, used air-free water and applied a considerable hydrostatic pressure, and still obtained a constant increase in reading (freezing).

Schuller and Wartha, 1888, used the same apparatus with water not air-free and obtained a continuous decrease in reading (melting). Boys, Mond, Ramsay and Shields found a continuous increase in their instrument and compensated for it by surrounding the bulb with an air jacket, thus balancing the freezing by a continuous melting.

Dieterici used a modified form of the Dewar flask, surrounding the calorimeter with a vacuum jacket and thus considerably reduced the creep.

One of the authors, with Mr. Lucas, had previously made an effort to reduce the creep by surrounding the calorimeter with freezing-point mixtures of great purity, such as clean, freshly fallen snow and distilled water, but had not succeeded. It occurred to the authors, after trying tap water with and without air, and water from the clean blocks of melted river ice, all without success, that it was better to use distilled water, eliminate so uncertain a quantity as the dissolved air, and add a very small quantity of cane sugar to the water before filling the bulb of the instrument.

After several trials with various strengths, we found that a solution of cane sugar containing .18 gram to the liter practically did away with the creep when the instrument was immersed in clear, cracked river ice and tap water. The capillary tube of the instrument had a bore of .0006619 c.c. per millimeter, and the actual change in reading which we obtained was less than 5 mm. in 14 hours, and was constant for over two days. Changing the height of the capillary tube was found to have only a very small effect on the creep.

The authors strongly recommend to those desiring to use the Bunsen ice calorimeter that the bulb be filled with a solution containing from .15 to .18 gram per liter, and boiled free from air. The solution is so

weak that the sugar added can not be detected by its taste, and the arrangement is the simplest way to avoid an otherwise uncertain and troublesome correction.

The Resistance Temperature Coefficient and the Coefficient of Expansion of Carbon: G. W. STEWART, University of North Dakota.

With the exception of the diamond and charcoal, carbon in its various forms conducts electricity metallically. Its resistance temperature coefficient is, however, negative. This paper accounts for the apparent negative coefficient by assuming the changes in resistance to be due to the expansion of the particles of carbon.

Assuming this explanation to be the correct one, experiments were performed to obtain the coefficient of expansion of carbon. The carbon used was in the form of films made of commercial lampblack and a lacquer called "zapon L." The apparent resistance temperature coefficient of the films and the effect of the expansion of the hard rubber base upon which the films were placed were measured, and the actual coefficient of expansion of the carbon particles was computed. The result obtained shows the coefficient to be about 0.0003, which is from ten to thirty times that of the pure metals.

The Temperature Coefficient of the Moving Coil Galvanometer: ANTHONY ZELENY and O. HOVDA, University of Minnesota.

The temperature coefficient of a moving coil galvanometer having a cast-iron magnet, was determined in order that the change in the sensibility could be calculated when the instrument is used at different temperatures.

Since the temperature coefficient depends upon the magnet, the suspensions and the coil, and in different relations for different kinds of measurements, the coefficients of these different parts were determined separately. These are combined in their proper relation to determine the temperature coefficients for current, potential and ballistic measurements.

The Effect of Tension on Thermal and Electrical Conductivity: N. F. SMITH, Olivet College.

Two metal bars called A and B of the same material, each $\frac{5}{16}$ of an inch in diameter and about one meter long, are mounted horizontally about 10 cm. apart. One end of each bar is held in a clutch made from a heavy block of copper which is heated and maintained at a constant temperature. By means of thermo-electric couples sliding on the bars a point is determined on B which has the same temperature as a given point on A when the steady state is reached. B is then subjected to a stretching force while the condition of A remains unchanged. When the steady state is again reached the couple on B is shifted till it is again at a point where the temperature is the same as at the given point on A. The stretching force is increased, step by step, up to the maximum which the bar will withstand. It is assumed that the thermal conductivity is proportional to the square of the length to the position of the thermo-electric couple. At each step the electrical resistances of the two bars are compared by a modification of Kelvin's double bridge method.

Observations have been made on bars of several different metals and each shows an *increase* in the thermal conductivity with the stretching force. The maximum increase is about 1.7 per cent. At the same time the electrical conductivity *diminishes,* the variation being about the same as that found by other experimenters. The length of time that the stress is applied has a marked effect upon the thermal conductivity.

Some Cases of Excessive Damping of Torsional Vibrations: K. E. Guthe, Iowa State University.

The decrease of the logarithmic decrement with the amplitude, frequently observed in torsional vibrations, is usually extremely small. It is considered as closely connected with the elastic after-effect. Wires of platinum-iridium which are practically free from such after-effect have not alone a large logarithmic decrement, but show also a decided decrease of decrement as well as period with decreasing amplitude. This is especially pronounced in a 40 per cent. platinum-iridium wire whose logarithmic decrement decreased from 0.0137 to 0.0025, while the amplitudes decreased from 5.7 to 0.85 degrees. The corresponding change in the period was from 7.350 to 7.175 seconds. The decrease in amplitude is nearly proportional to the square of the amplitude. With different moments of inertia suspended from the wire the values of the decrement remained the same for the same amplitudes.

Similar effects, though less pronounced, were observed with wires containing a smaller percentage of iridium and in drawn wires of other materials. It was attempted to explain the phenomena by the assumption that the disappearance of the elastic after-effect is very rapid.

The increase of the logarithmic decrement upon drawing was explained by Beilby's theory of the effect of mechanical hardening. A carbon filament was shown to have a large decrement; the electrolytic deposition of hydrogen upon palladium increased the logarithmic decrement fivefold. In conclusion, it was pointed out that the conditions under which a wire is annealed by heating greatly influence its elastic properties.

F. N. Cole,
Secretary

(To be concluded)

THE CARNEGIE INSTITUTION OF WASHINGTON[1]

Referring to the individual reports of the heads of departments for a more adequate account of the year's work on the numerous and diverse fields of departmental activity, the following summary may suffice to show the trend of current progress.

Department of Botanical Research

This department is engaged on a series of problems whose elucidation can not fail to be of the greatest interest and value, whether applied to the restricted field of botany or to the broader domain of biology. By means of observation, experiment and measurement it is proposed to determine, as nearly as may be, the conditions of development, growth, distribution, migration and variation of desert plants. Thus, in addition to systematic studies of the forms and distribution of these plants, there must be carried on studies of the factors of temperature, rainfall, evaporation, soil moisture and anatomical and physiological adaptability. The location of the desert laboratory in a country affording a wide range of plant forms, as well as a wide range of conditions in altitude, temperature, soil moisture and soil composition, presents unequaled opportunities for such studies.

Along with these lines of work, the anatomical, physical and physiological researches of the department staff have already resulted in noteworthy contributions to biological science. Among these, reference may be made especially to publication No. 81, in which Director MacDougal gives an account of the production of a new species of plant by an application of chemical fluids to the parent plant seeds during the period of germination. This remarkable achievement must be regarded as one

[1] From the annual report of the president for 1907.